Review

The evolution of lean beef: Identifying lean beef in today's U.S. marketplace

Shalene H. McNeill [a,*,1], Kerri B. Harris [b,2], Thomas G. Field [c,3], Mary E. Van Elswyk [d]

[a] Human Nutrition Research, National Cattlemen's Beef Association, 9110 E. Nichols Ave. #300, Centennial, CO 80112, United States
[b] Center for Food Safety, Department of Animal Science, Texas A&M University, College Station TX, 77843–2471, United States
[c] National Cattlemen's Beef Association, 9110 E. Nichols Ave. #300, Centennial, CO 80112, United States
[d] Van Elswyk Consulting Inc. 10350 Macedonia St., Longmont, CO 80503, United States

ARTICLE INFO

ABSTRACT

Changes in cattle breeding and management coupled with extensive trimming of visible fat from retail cuts have resulted in the wide-spread availability of lean beef to U.S. consumers. Despite these changes, there is limited awareness regarding the reduced total fat content and the favorable fatty acid profile of beef. Relative to the calories it contributes, the impact of beef on the nutritional quality of the American diet via its contribution of protein and certain key micronutrients is often under appreciated. The following discussion documents the progressive reduction in fat content of U.S. beef during the past 30 years, highlights ongoing efforts to update United States Department of Agriculture nutrient data for beef, and summarizes findings from randomized controlled trials of beef and plasma lipid outcomes. Beef is a popular, nutrient-dense food and the availability of at least 29 lean cuts of beef in the U.S. marketplace can help consumers meet their cardiovascular health goals.

© 2011 Elsevier Ltd. All rights reserved.

Contents

1. Introduction

For more than three decades, beginning with the 1977 Dietary Goals for the United States, government-issued dietary guidance has emphasized the need for Americans to decrease their intake of total fat, saturated fat, and cholesterol while increasing the amount of polyunsaturated fat and, more recently, monounsaturated fatty acids (Dietary Guidelines Advisory Committee, 2010; U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010). Taste is likely the most common reason that Americans consume beef, but total and saturated fat content of beef may be among the reasons Americans choose to eat less beef in their diet. Recent U.S. survey data indicate that 63% of consumers are trying to consume less animal fat (International Food Information Council Foundation, 2009), and 41% of consumers are estimated to have decreased their consumption of beef between 2002 and 2008

* Corresponding author. Tel.: +1 720 352 0172; fax: +1 303 774 8936.
E-mail addresses: smcneill@beef.org (S.H. McNeill), kharris@tamu.edu (K.B. Harris), tfield@beef.org (T.G. Field), mveconsulting@q.com (M.E. Van Elswyk).
[1] Tel.: +1 830 569 0046; fax: +1 830 569 8182.
[2] Tel.: +1 979 862 3643; fax: +1 979 862 3075.
[3] Tel.: +1 303 830 3378; fax: +1 303 850 6921.

(American Dietetic Association, 2008). Another consumer survey of 2000 U.S. adults found that 53% cited red meat as being the "least healthy" protein among red meat, chicken/poultry, fish/seafood or pork (Mintel Oxygen, 2008). Survey findings also suggest a higher proportion of U.S. dietitians regard beef as a greater source of saturated fat than pork, poultry, or dairy products (unpublished data, 2007), even though dairy products are the largest contributor to saturated fat intake in the American diet (Dietary Guidelines Advisory Committee, 2010). In order to help today's consumers make educated dietary decisions, it is important that nutrition professionals have access to the latest evidence from clinical trials and the most up to date nutrient composition data for beef. This review will document the progressive reduction in fat content of U.S. beef during the past 30 years, highlight ongoing efforts to update United States Department of Agriculture (USDA) nutrient reference data for beef, and summarize findings from randomized controlled trials of beef intake and plasma lipid outcomes.

2. Beef production and trimming practices contribute to leaner U.S. beef

The availability of leaner beef in the U.S. is due to a collective effort over three decades throughout the entire U.S. beef production and merchandising chain. A similar experience is reported in the production of red meat in the U.K with just over 20 years of change in animal husbandry resulting in 30% reduced carcass fat for pork, 15% for beef and 10% for lamb (Higgs, 2000). The following discussion will detail changes in breeding and management along with trimming practices of processors, retailers, and food service operators that has led to an estimated 44% reduction in available total fat (from 13% to 7%) and a 29% reduction in saturated fat per capita (from 13% to 9%) contributed by beef as calculated from food disappearance data (Hiza and Bente, 2007).

2.1. Decreased carcass fat through change in U.S. breeding and management

Improvements of per unit production efficiency in a quest for more sustainable profitability along with greater consumer focus have been cattle industry drivers for the past four decades. Beginning in the 1970s and continuing in earnest well until the 1980s, U.S. cattlemen imported a significant number of cattle of various breeds from Europe (Field, 2007). This influx of Continental breeds changed U.S. beef cattle population significantly and, when coupled with other innovations available to the beef industry, resulted in several important outcomes:

1. Fed cattle could be taken to heavier finished weights with improved carcass cutability.
2. Efficiencies of production could be gained from incorporating technologies such as growth promotants that increased lean yield per animal.
3. The availability of high speed computing made national cattle genetic evaluation both possible and practical.
4. Utilization of both additive and non-additive genetic effects via focused selection strategies and planned crossbreeding systems optimized the production of beef that was acceptable in both flavor and leanness.
   (Field, 2007)

The characterization of British and Continental breeds of cattle in the Beef Germplasm Evaluation project at the ARS Meat Animal Research Center demonstrates that British breeds excel in producing carcasses with a high percentage of superior USDA quality grades (enhanced palatability) while Continental breeds provide superior cutability (leanness) as compared to British breeds (Table 1). In an effort to take advantage of these unique genetic differences, the

mainstream cattle producer created cattle that were approximately half British and half Continental in genetic composition in response to market signals to reduce trimmable fat from the carcass while retaining appropriate levels of marbling (Doherty et al., 1999; Field, 2007).

Genetic evaluation innovations allowed seedstock producers to more precisely focus selection pressure on multiple traits of economic importance while providing their customers herd bulls that were more specifically characterized for their ability to transmit superior genetic merit particularly in regard to the primary carcass value influencing traits of carcass weight, marbling score, ribeye area, and backfat thickness. Seedstock producers of both British and Continental cattle were able to affect the genetic trend within their respective breeds for these traits (Tables 2 and 3). These genetic trends show that breeders were able to increase carcass weight, marbling, and muscularity while reducing or holding constant carcass fat thickness. The interaction of breed and diet also influenced the deposition of individual fatty acid classes. For example, divergent effects on saturated fatty acid deposition in response to annual vs. perennial grass feeding is reported for two common U.S. cattle breeds, Angus and Simmental (Itoh et al., 1999). Successful reduction in total and saturated fat through combined improvements in beef breeding and management practices are evident from the current nutrient data for beef from the USDA National Nutrient Database for Standard Reference. Specifically, the total fat content for a completely trimmed sirloin steak, all grade average, has declined 34% from 1963 to 2010 and the saturated fat content has declined 17% (Watt and Merrill, 1963; USDA, 2010; Fig. 1).

These trends have improved the value of beef carcasses by enhancing both palatability and leanness. Growth enhancement technologies also improve lean yield per head and reduce cost of gain (Field, 2007). U.S. cattle feeders have incorporated the use of growth enhancement technologies to the point that in 1999, more than 96% of cattle upon entering U.S. feed yards were implanted at least once (National Animal Health Monitoring System, 2000).

Taken in total, the U.S. fed cattle population performance in USDA Quality and Yield grade has altered significantly because the production sector responded to market signals. The series of National Beef Quality Audits funded by the Beef Checkoff delivered a consistent message to reduce subcutaneous fat while assuring appropriate levels of marbling to maintain beef palatability (Boleman et al., 1998; Garcia, et al., 2008; Lorenzen, et al., 1993; and McKenna, et al., 2002). Degree

Table 1
Percent USDA quality grade and yield grade performance from Meat Animal Research Center Germplasm Evaluation Project[a].

	British breeds [d] (%)	Continental breeds [e] (%)
USDA yield grade[b]		
1	4.5	22.4
2	29.2	47.4
3	43.4	26.9
4	22.9	3.3
USDA quality grade[c]		
Prime	2.1	0.3
Choice	84.0	57.3
Select	13.9	42.1
Standard	0.0	0.3

[a] Wheeler et al., 2006.
[b] Estimates percent of carcass weight converted to boneless, closely trimmed retail products. Yield grade 1 has the highest percent cutability while a YG 5 would have poor cutability.
[c] Estimates palatability based on assessments of intramuscular fat and maturity. Prime and Choice have the most desirable palatability while Standard (carcasses not presented to be quality graded) typically have poorer palatability and tenderness.
[d] Angus, Hereford and Red Angus.
[e] Charolais, Gelbvieh, Limousin, and Simmental.

Table 2
Genetic trend in Expected Progeny Differences (EPD) for Carcass traits of British breed cattle[a].

Year	Carcass weight EPD[b]			Marbling EPD			Ribeye area EPD			Backfat thickness EPD		
	A[c]	H[d]	RA[e]	A	H	RA	A	H	RA	A	H	
1975	0	NA	−9	0	NA	−.06	.01	NA	.04	0	NA	−.01
1980	0	NA	−5	.01	NA	−.05	−.01	NA	.02	0	NA	−.01
1985	0	NA	4	.04	NA	−.06	−.03	NA	−.01	−.003	NA	−.01
1990	3	NA	11	.10	−.02	−.06	−.04	−.08	−.02	−.003	−.03	−.02
1995	4	NA	19	.15	−.01	−.05	−.06	−.02	−.05	0	−.03	−.01
2000	7	NA	25	.21	−.01	−.02	−.02	.05	−.05	.003	−.02	−.01
2005	11	NA	32	.34	−.01	.03	.03	.14	.01	.007	−.01	−.01
2009	14	NA	36	.43	−.04	.07	.07	.22	.07	.012	.002	0.0

[a] Source: National Sire Evaluation Databases of the American Angus Association, American Hereford Association and the Red Angus Association of America.
[b] Expected progeny differences.
[c] Angus, [d] Herford, [e] Red Angus.

of marbling is the primary determination of quality grade. Marbling is determined by the amount and distribution of marbling in the ribeye muscle at the cut surface after the carcass has been ribbed between the 12th and 13th ribs. Yield grade estimates the amount of boneless, closely trimmed retail cuts available from the high-value parts of the carcass with Yield Grade 1 being the highest yielding carcass. According to the Agricultural Marketing Service of USDA, in 1974, 75% of the fed cattle in the U.S. were the highest quality grades (USDA Choice or Prime) with only 30% categorized as USDA Yield Grade 1 and 2. By 1996, 61% of fed cattle met the standards for USDA Yield Grade 1 and 2 with 55% graded as USDA Choice or Prime thus rebalancing the grade mix. In response to strong signals for improved eating quality, the industry shifted the grade distribution by 2010 such that approximately 55% and 64% of beef carcasses qualified as USDA Yield Grade 1 and 2 and USDA Prime and Choice, respectively (Table 4).

2.2. Decreased carcass fat through change in butchery practice

The first U.S. Dietary Guidelines for Americans were issued in 1980. Included in the 1980 guidelines were recommendations to "choose lean meat, fish, poultry, dry beans and peas as your protein sources" and "trim excess fat off meats" in an effort "to avoid too much fat, saturated fat, and cholesterol." (USDA and U.S. Department of Health and Human Services, 1980) These recommendations increased consumer demand for leaner beef cuts and increased trimming of visible fat at the retail level. In the 1980s, most beef in the U.S. retail meat case had 1.3 cm (0.5 in.) of external fat (Cross et al., 1986). The need to meet consumer demand by providing retail cuts with less visible fat was confirmed by the results of the National Consumer Retail Beef Study (NCRBS). Conducted in 1983, the NCRBS examined the interaction of quality grade, price, and external fat trim. The results indicated that consumers were less willing to purchase beef cuts with excess external fat, regardless of grade, and would be willing to pay a slightly higher price per pound for closely trimmed cuts as consumers considered cut with 0.8 cm or less external fat to be more healthful (Cross et al., 1986). Results indicated that lesser grade beef cuts were perceived as more healthful with U.S. Good grade cuts,

identified as "Select" in the NCRBS, rated high by consumers for leanness. Interestingly, results of the NCRBS were used as the impetus to change the name of the U.S. Good grade to U.S. Select as "Good" was seen as communicating a negative image to consumers but "Select" was positively associated with leanness. U.S. Select grade beef contains slight marbling and is derived primarily from Yield Grade 2 or higher carcasses. By 1988 the average external fat thickness for all retail beef cuts had been trimmed to an overall mean of 0.31 cm (Savell et al., 1991). More recent data from 2005 show that the external fat on retail beef cuts averages 0.24 cm, virtually devoid of external fat, marking an 81% decrease in external fat on retail cuts in 26 years (Savell, et al., 2005). Furthermore, national consumer studies report that 77% of consumers prefer to trim visible fat from beef before consuming (Cattlemen's Beef Board and National Cattlemen's Beef Association, 2010). Through the combination of changes in beef breeding and management and availability of near zero external fat through trimming, 63% of U.S. fresh whole muscle beef cuts, including 15 of the top 20 most popular currently sold at retail, meet Food and Drug Administration (FDA) guidelines for lean, having less than 10 g of total fat, 4.5 g or less of saturated fat and less than 95 mg of cholesterol per serving and per 100 g (FDA, 2008). In total, there are at least 29 fresh cuts of cooked beef that meet the FDA definition of lean (Fig. 2).

2.3. Communicating lean beef availability

Despite the widespread availability of lean beef cuts, survey research has found that, on average, U.S. registered dietitians believe there are only about seven cuts of lean beef, and more than half believe there are only three to five lean beef cuts available to consumers (unpublished data, 2007). Communicating the availability of lean beef has likely been hindered, at least in part, by infrequent updates of the nutrient composition data for various beef cuts in the USDA National Nutrient Database for Standard Release. For example, in 2006, sampling of retail cuts from the chuck, rib, loin, or round identified 11 total cuts that averaged 35% less external fat than was reported in the USDA nutrient database (Mason, et al., 2009).

Table 3
Genetic trend for carcass trait Expected Progeny Differences (EPD) of continental cattle[a].

Year	Carcass weight EPD			Marbling EPD			Ribeye area EPD			Backfat thickness EPD		
	S[b]	C[c]	L[d]	S	C	L	S	C	L	S	C	L
1991	−4.0	4.6	−7.4	−.03	0.0	−.07	−.12	.03	.24	0.0	−.003	−.15
1995	−2.9	6.0	−3.0	.01	.01	−.07	−.08	.06	.29	0.0	−.003	−.14
2000	−2.8	9.0	3.2	.06	.01	−.08	−.02	.09	.35	0.0	−.002	−.08
2005	−2.4	11.9	10.1	.10	.01	−.06	.04	.14	.39	.01	−.001	−.06
2009	−1.7	14.1	19.4	.15	.01	−.04	.10	.18	.49	.01	−.001	−.04

[a] Sources: National Genetic Evaluation Databases of the American Simmental Association, American International Charolais Association, and the North American Limousin Foundation.
[b] Simmental, [c] Charolais, [d] Limousin.
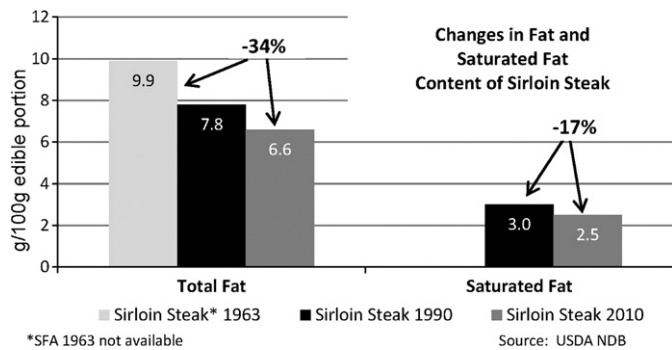
Fig. 1. Total fat and saturated fatty acid (SFA) content of sirloin steak, completely trimmed of external fat, as reported by Watt and Merrill (1963) and the USDA National Nutrient Database (1990; 2010). Data reported for 100 g of choice grade, cooked via broiling.

Inaccurate estimation of the total and saturated fat content of beef available in the marketplace can impact national food intake survey data that links to national nutrient databases. Outdated national nutrient data for beef is not a problem unique to the U.S. In a recent comparison of selected nutrients in beef according to food composition databases from various countries, Wyness et al. (2011) noted a range of 3.6–10.4 g total fat per 100 g of raw, lean, beef. Wyness et al. (2011) listed variable time periods of analyses, with some being conducted more recently than others or with newer methods, as one of the reasons for this range.

Through a nutrition research grant from The Beef Checkoff, USDA is leading a Beef Nutrient Database Improvement Initiative to update the nutrient composition data of beef retail cuts. The first revision of beef nutrient data from this initiative has resulted in significant updates to the nutrient information in the USDA Nutrient Database and the release of the USDA Nutrient Data Set for Retail Beef Cuts, Release 1.0 (Patterson et al., 2009). This recently released data set represents the collaborative effort of the USDA Nutrient Data Laboratory, The Beef Checkoff program, and various U.S. universities in three different studies designed to update or expand the data for beef cuts including the *1/8 Inch Study*, the *Beef Value Cuts Study (BVC)*, and the *Beef Nutrient Database Improvement Study Phase I (NDI Phase 1)*. The *1/8 Inch Study* determined the physical characteristics and nutrient composition of 13 raw and cooked retail cuts with fat trim levels representative of current retail cuts and provided analytical data not previously available in the USDA Nutrient Database (Patterson et al., 2009). The *BVC study* provided nutrient information

Table 4
Grade performance of U.S. fed cattle (1996–2010)[a].

	1996	2000	2005	2010
USDA yield grade[a] *(%)*				
1	12.7	10.9	10.5	11.9
2	48.2	45.6	40.4	40.0
3	37.2	41.0	39.9	39.9
4	1.5	2.1	8.0	7.3
5	0.2	0.2	1.0	0.8
USDA quality grade[b] *(%)*				
Prime	2.1	3.2	2.9	3.1
Choice	53.2	52.4	52.9	60.9
Select	32.7	36.0	36.5	29.8
Standard and no roll	12.0	8.4	7.8	8.2

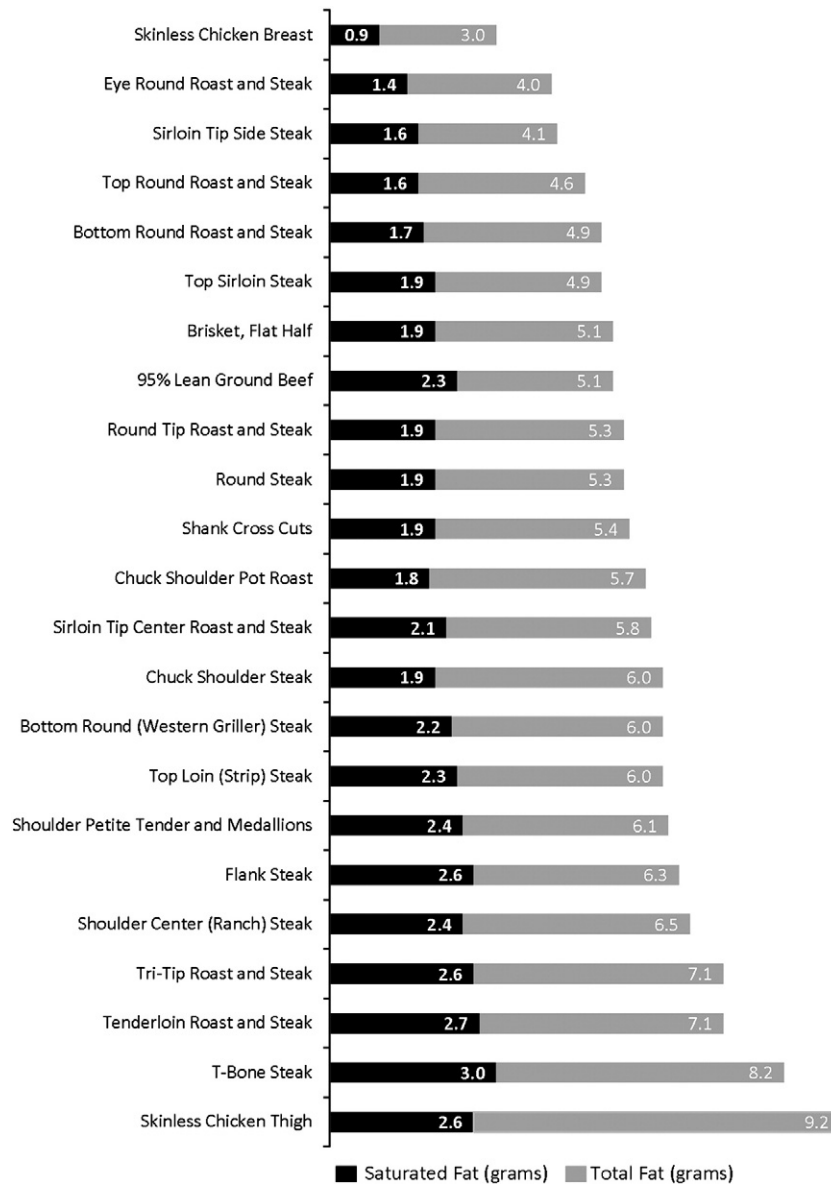[a] Source: Meat Grading and Certification Branch, USDA, 2011.
[b] Estimates percent of carcass weight converted to boneless, closely trimmed retail products. Yield grade 1 has the highest percent cutability while a YG 5 would have poor cutability.
[b] Estimates palatability based on assessments of intramuscular fat and maturity. Prime and Choice have the most desirable palatability while Standard and no roll (carcasses not presented to be quality graded) typically have poorer palatability and tenderness.

for a new line of retail roasts and steaks including the top blade steak (Infraspinatus), shoulder top and center steaks (Triceps brachii), shounder tender (Teres major), tip center (Rectus femoris), tip side (Vastus lateralis) and bottom round (Biceps femoris). Finally, the *NDI Phase I* study focused on providing nutrient data for all retail cuts from the beef chuck that lacked data in the USDA Nutrient Database. Whereas the USDA Nutrient Data Set for Retail Beef Cuts, Release 1.0 is designed to provide retailers easier access to the most current and accurate beef nutrient data for "on-pack" nutrition labeling, it is also a resource for consumers and health professionals to quickly and easily determine the complete nutrient profile of 10 commonly consumed beef cuts. Release 1.0 is the first of continuously planned updates. Also included among recent database updates is the USDA Ground Beef Calculator, an on-line nutrient composition tool recently developed to aid consumers, researchers, and health professionals obtain accurate data for ground/minced beef (USDA, 2009). Estimates suggest that 42% of beef consumed in the U.S. is purchased ground at retail (Davis and Lin, 2005). Whereas, 95% lean ground beef meets the FDA definition of lean (FDA, 2008), ground beef is unique in that a wide range of products ranging from 5 to 30% fat are available in most retail stores and are *voluntarily* labeled with either the percentage lean or fat content. Perhaps one of the greatest opportunities to communicate the nutrient composition of ground beef comes from the recently finalized rule for Nutrition Labeling of Single Ingredient Products and Ground or Chopped Meat and Poultry Products, by USDA Food Safety and Inspection Service (USDA FSIS, 2010). This rule *mandates* nutrition information on pack for all ground or chopped single-ingredient meat and poultry products and on-pack or at point of purchase nutrition labeling of major cuts of single-ingredient, raw meat and poultry. The rule also allows "Percent Lean" (% lean) use on labels of ground or chopped products that do not meet regulatory criteria for "low-fat" provided that a statement of fat percentage (or % fat) is also displayed next to % lean in the same font size on the label. Compliance with this rule is required by January 2012. In the meantime, the USDA Ground Beef Calculator can help consumers and health professionals alike to decode the fat/lean content of various ground beef offerings and allow continued calculation of nutrients not required by labeling regulation at any fat level between 5 and 30%

3. Beef consumption and cardiovascular health endpoints

The recommendation to restrict beef consumption is most often rooted in the assumption that beef is over-consumed and that the fatty acid profile is counterproductive to optimal health (Hu, et al., 1999). However, in a recent analysis of U.S. National Health and Nutrition Examination Survey (NHANES) food survey data adults (19–50 years) total beef and lean beef consumption equated to 49.3 g and 45.5 g, respectively of the daily 142–198 g total meat and meat equivalents (i.e. beans and nuts) recommended by the USDA "MyPyramid" food plan for adults (Zanovec et al., 2010). These data indicate that beef is moderately consumed despite its popularity with consumers. Analysis of NHANES data has also found that, in healthy women age 50 and older, those who adhered most closely to a dietary pattern with beef as a primary source of protein had the lowest probability of being overweight or obese, a greater likelihood of normal systolic blood pressure, and an overall diet that conformed most closely with the 2005 U.S. Dietary Guidelines for Americans (Lopez et al., 2008). For U.S. children, NHANES data indicate that those 4–8 years consume 22.7 g total beef and 20.8 g lean beef and those 9–13 years consume 37 g total beef with 34 g as lean beef contributing only 9.8–13.9% of total protein, again suggesting modest consumption of beef (O'Neil et al., 2011). Based on these data, beef intake in the average American diet appears well within the recommendations made by the 2010 Dietary Guidelines Advisory Committee (DGAC).

Cut	Saturated Fat (grams)	Total Fat (grams)
Skinless Chicken Breast	0.9	3.0
Eye Round Roast and Steak	1.4	4.0
Sirloin Tip Side Steak	1.6	4.1
Top Round Roast and Steak	1.6	4.6
Bottom Round Roast and Steak	1.7	4.9
Top Sirloin Steak	1.9	4.9
Brisket, Flat Half	1.9	5.1
95% Lean Ground Beef	2.3	5.1
Round Tip Roast and Steak	1.9	5.3
Round Steak	1.9	5.3
Shank Cross Cuts	1.9	5.4
Chuck Shoulder Pot Roast	1.8	5.7
Sirloin Tip Center Roast and Steak	2.1	5.8
Chuck Shoulder Steak	1.9	6.0
Bottom Round (Western Griller) Steak	2.2	6.0
Top Loin (Strip) Steak	2.3	6.0
Shoulder Petite Tender and Medallions	2.4	6.1
Flank Steak	2.6	6.3
Shoulder Center (Ranch) Steak	2.4	6.5
Tri-Tip Roast and Steak	2.6	7.1
Tenderloin Roast and Steak	2.7	7.1
T-Bone Steak	3.0	8.2
Skinless Chicken Thigh	2.6	9.2

■ Saturated Fat (grams)   ■ Total Fat (grams)

Fig. 2. Cuts of meat that meet FDA guidelines for lean. Roast and steak cuts are combined for illustration. All data based on USDA Nutrient Database for Standard Reference, Release 23 (USDA, 2010). Cooked, lean only, all visible fat removed based on "all grades" designation, if available (aggregate of USDA Select and Choice based on retail volume), otherwise average of USDA Select and Choice. Copyright courtesy of the Beef Checkoff.

In addition, consistent evidence from clinical trials indicates that the inclusion of lean beef in a well-balanced diet designed to manage cardiovascular risk is equally as effective as including lean white meat for low-density lipoprotein cholesterol (LDL) reduction (Table 5). In fact, a systematic review of red meat studies provides supportive evidence that, when included as part of a diet low in saturated fat (≤10%), fresh red meat from both grass-fed and grain-finished animals is associated with reductions in LDL in both healthy and mildly hypercholesterolemic individuals (Li et al., 2005).

These results are not surprising when the fatty acid profile of beef is considered. Regardless of feeding regime roughly fifty percent of the fatty acids in U.S. beef are monounsaturated (USDA, 2009a), and nearly one-third of the saturated fat in beef is stearic acid, a fatty acid that has been shown to have a neutral effect on LDL cholesterol (DGAC, 2010). Reports from the U.S. Institute of Medicine (IOM, 2005), the 2010 DGAC and, most recently, Food and Agriculture Organization (2010) all recognize the neutral effect of stearic acid on LDL-cholesterol. Whereas reducing dietary saturated fat has generally been thought to improve cardiovascular health, a recent meta-analysis of prospective cohort studies found that saturated fat was not associated with an increased risk of heart disease (pooled relative risk estimate 1.07 between intake quartiles) (Siri-Tarino et al., 2010). Research also suggests that *trans* fatty acid intake, a diet with a high glycemic index, and high dietary salt are more significant risk factors for heart disease than dietary saturated fat (Danaei et al., 2009). In fact, the higher sodium content of processed red meats is a likely contributor to recent observations that processed meats, but not fresh cuts, are associated with an increased risk for cardiovascular disease (Micha et al., 2010).

4. Contribution of beef to nutrient adequacy

Looking beyond fat, beef significantly contributes to the overall nutrient intake of Americans. As noted by the 2010 DGAC meat, including beef, is commonly recognized as an important source of high-quality protein and highly bioavailable iron (DGAC, 2010). U.S. dietary survey data indicate that fresh beef is the number one source of protein, vitamin B_{12}, and zinc (Cotton et al., 2004) in the American

Table 5
Beef versus other lean animal protein and LDL outcomes in individuals at increased risk for heart disease.

Study	Study type/duration	Study population	Test diets	Intervention	Results
Beauchesne-Rondeau et al., 2003 (Canada)	Cross-over 3×26-day test periods separated by 6-week washouts	Mild hyperC[a] and overweight men/n = 18	<30% of calories from fat; <10% SFA[b]; 250 mg chol[c]/day. Beef, chicken or fish provided as prepared lunch or dinner. Breakfast self-selected.	425 g/day (average) lean beef (sirloin strip), fish (lean white), or chicken (skinless breast or ground turkey).	All diets significantly ↓ plasma LDL-C[d] 5-9%, Beef − 7–8%; no significant difference between diets.
Leaf and Hatcher, 2009 (U.S.A)	Cross-over 3×28-day test periods, no washout.	HyperC and overweight men and women/n = 10	Cholesterol-free Diet 25 − 24% calories from fat; 8.1% SFA, 0 mg chol/day from liquid formula; Cholesterol-free Diet 40 − 40% calories from fat; 0 mg chol/day; White Fish Diet 25–24% calories from fat; 8.1% SFA; 50 mg/1000 kcal; White Fish Diet 40 − 40% calories from fat; 12.3% SFA; 50 mg chol/1000 kcal; Ground Beef Diet 25 − 24% calories from fat; 10.8% SFA; 65 mg chol/1000 kcal; Ground Beef Diet 40 − 40% calories from fat; 15.2% SFA; 65 mg chol/1000 kcal. All meals prepared by research staff, 2 meals eaten under supervision/day.	276 g/1000 kcal lean fish or ground beef (15% fat).	Cholesterol free diet significantly lowered plasma LDL-C 12% compared to fish or beef. No significant difference in LDL-C following fish or beef combined with either level of fat intake.
Mahon et al. 2007 (U.S.A.)	RCT[e] 9 weeks	HyperC, overweight, post-menopausal women/n = 54	1000 kcal lacto-ovo vegetarian weight-loss diet with 250 kcal added as various protein or CHO[f]/fat. Diets ≤30% of calories from fat. Test article provided, other foods self-purchased and prepared.	Additional 250 kcal as lean beef (tenderloin), lean chicken, or non-meat CHO/fat	All diets significantly ↓ plasma LDL-C ~12%, no significant difference between diets.
Melanson et al. 2003 (U.S.A)	RCT 10 weeks	Mild hyperC, obese, women/ n = 61	Hypocaloric (−500 kcal/d) compared to usual, 24.5% calories from fat; 6.4% SFA; 125 mg chol/day. All foods self-purchased and prepared.	Primary protein source (70 g/d) as lean beef (sirloin, top round, 94% ground) or lean chicken (skinless breast, thighs, ground chicken)	Plasma LDL-C ↓ 7–11% from baseline, no significant difference between lean beef vs. lean chicken.
Scott et al. 1994 (U.S.A.)	RCT 13 weeks	HyperC[1] men/n = 38	Stabilization diet: 40% calories from fat; 18% SFA; 400 mg chol/day; Test diet: 30% of calories total fat; <10% as SFA; 250 mg chol/day. All foods other than low calorie, free choice provided.	Stabilization: 45 g/d beef (cut not specified) or chicken (cut not specified) during 5 week period Test: 85 g/d lean beef (strip loin steak) or lean chicken during 5 week test period	Significant 9–11% ↓in plasma LDL-C in response to either lean beef or chicken. No significant difference between protein sources.
Scott et al. 1991 (U.S.A.)	RCT 11 weeks	Mild hyperC men/n = 46	Stabilization diet: 35% calories from fat; 8% SFA; 222 mg chol/day Test diet: 29% of calories from fat; 6% as SFA; 228 mg chol/day. All foods other than low calorie, free choice provided.	Stabilization: 226 g/d beef (13.6% fat, cut not specified) for 4 weeks Test: 226 g/d lean beef (top round, top loin steak) or lean chicken (breast) and fish (red snapper) during 4 week test	No effect of either lean beef or chicken/fish during test period on plasma LDL-C.
Roussell et al., 2010 (U.S.A.)	Cross-over/4×35-day test periods separated by 14 day washout	Mild hyper C men and women/n = 37	Average American Diet (33% calories from fat; 11.3% SFA); DASH[g] Diet (28% calories from fat; 6.5% SFA); BOLD[h] Diet (28% calories from fat; 6.4% SFA); BOLD + Diet (28% calories rom fat; 6.1% SFA).	Average American Diet: 28 g lean beef /day(cuts not specified);DASH Diet: 50 g lean beef/day;BOLD Diet − 126 g lean beef/day; BOLD + Diet: 177 g lean beef/day	All diets resulted in a significant, ~8%↓in plasma LDL-C compared with the Average American Diet

[a] Hyper C = Hypercholesterolemic − mild defined as plasma cholesterol >200 mg/d but <240 mg/dl.
[b] SFA = Saturated fat as a percent of total calories.
[c] chol = dietary cholesterol.
[d] LDL-C = low-density lipoprotein cholesterol.
[e] RCT = randomized, controlled trial.
[f] CHO = carbohydrate.
[g] DASH = Dietary approaches to stop hypertension.
[h] BOLD = Beef in an optimal lean diet.

diet and a leading source of selenium, iron, and monounsaturated fatty acids (Zanovec et al., 2010). On average, in a 85-g cooked serving, the 29 lean cuts of beef (Fig. 2) contribute 8% of calories (154 cal) to a 2000 calorie diet, 50% of the daily value for protein, 45%–62% U.S. Recommended Dietary Allowance (RDA; adult under 50 years male–female, respectively) for zinc, 91% of the adult RDA for vitamin B_{12}, 52% of selenium, 21% of phosphorus, 31–36% of niacin, 31% of vitamin B_6, 27–12% of iron, and 13–15% of riboflavin (USDA, 2010).

5. Conclusion

Lean beef cuts are widely available in the U.S. marketplace as the result of progressive changes over the past 30 years in cattle breeding and management practices and retail trimming. Numerous updated nutrient data tools are available from USDA and The Beef Checkoff to enable consumers and health professionals to confidently identify the best beef choices to meet nutritional needs. Beef is a popular, nutrient-dense protein source and lean beef can help consumers meet their cardiovascular health goals.

References

American Angus Association (2011). Available at. http://www.angus.org Accessed April 18, 2011

American Dietetic Association (2008). *American Dietetic Association's Consumer Opinion Survey.* Nutrition and You: Trends 2008 Available at:. http://old.eatright.org/ada/files/Overall_Findings_ADA_Trends_2008.pdf Accessed July 15, 2010

American Hereford Association (2011). Available at. http://www.hereford.org Accessed April 18, 2011

American International Charolais Association (2011). Available at. http://www.charolaisusa.org Accessed April 18, 2011

American Simmental Association (2011). Available at. http://www.simmental.org Accessed April 18, 2011.

Beauchesne-Rondeau, E., Gascon, A., Bergeron, J., & Jacques, H. (2003). Plasma lipids and lipoproteins in hypercholesterolemic men fed a lipid-lowering diet containing lean beef, lean fish, or poultry. *American Journal of Clinical Nutrition, 77,* 587–593.

Boleman, S. L., Boleman, S. J., Morgan, W. W., Hale, D. S., Griffin, D. B., Savell, J. W., et al. (1998). National Beef Quality Audit-1995: Survey of producer-related defects and carcass quality and quantity attributes. *Journal of Animal Science, 76,* 96–103.

Cattlemen's Beef Board and National Cattlemen's Beef Association (2010). Project Snapshot: Consumer perception of leaness. Available at: http://www.beefresearch.org/CMDocs/BeefResearch/Market%20Research/Consumer%20Perceptions%20of%20Leanness%20Snapshot%20031711.pdf Accessed April 5, 2011

Cotton, A. P., Subar, A. F., Friday, J. E., & Cook, A. (2004). Dietary sources of nutrients among US adults, 1994 to 1996. *Journal of the American Dietetic Association, 104,* 921–930.

Cross, H. R., Savell, J. W., & Francis, J. J. (1986). National Consumer Retail Beef Study. 8–11 June 1986. *Proceedings 39th Annual Reciprocal Meat Conference* (pp. 112–116). Champaign, Illinois: University of Illinois.

Danaei, G., Ding, E. L., Mozaffarian, D., Taylor, B., Rehm, J., Murray, C. J. L., & Ezzati, M. (2009). The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors. 6e1000058. *PLoS Medicine,* 1–23.

Davis, C., & Lin, B. H. (2005). *Factors affecting U.S. beef consumption.* Electronic Outlook Report from the Economic Research Service LDP-M-135-02.

Dietary Guidelines Advisory Committee (2010). Report of the dietary guidelines advisory committee on the dietary guidelines for Americans, 2010. Available at. http://www.cnpp.usda.gov/dietaryguidelines.htm Accessed April 5, 2011

Doherty, R. L., Field, T. G., Tatum, J. D., Belk, K. E., Scanga, J. A., & Smith, G. C. (1999). *Developing benchmarks to familiarize cattle producers with the benefits and risks associated with grid pricing.* The Professional Animal Scientist (15:2).

Field, T. G. (2007). *Beef production and management decisions* (5th ed.). Upper Saddle River, New Jersey, U.S.A: Pearson Prentice Hall.

Food and Agriculture Organization (2010). *FAO, 2010. Fats and fatty acids in human nutrition.* FAO Food and Nutrition Paper 91 ISSN 0254–4725.

Food and Drug Administration (2008). *Guidance for industry: A food labeling guide.* Appendix B: Additional requirements for nutrient content claims Available at. http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/FoodLabelingNutrition/FoodLabelingGuide/default.htm Accessed April 5, 2011

Garcia, L. G., Nicholson, K. L., Hoffman, T. W., Lawrence, T. E., Hale, D. S., Griffin, D. B., et al. (2008). National beef quality audit — 2005: Survey of targeted cattle and carcass characteristics related to quality, quantity, and value of fed steers and heifers. *Journal of Animal Science, 86,* 3533–3543.

Higgs, J. D. (2000). The changing nature of red meat: 20 years of improving nutritional quality. *Trends in Food Science & Technology, 11,* 85–95.

Hiza, H. A. B., & Bente, L. (2007). *Nutrient content of the U.S.* Food supply, 1909–2004: A summary report. (Home Economics research report No. 57). U.S: Department of Agriculture , Center for Nutrition Policy and Promotion.

Hu, F. B., Stampfer, M. J., Manson, J. E., Acherio, A., Colditz, G. A., Speizer, F. E., et al. (1999). Dietary saturated fats and their food sources in relation to the risk of coronary heart disease in women. *American Journal of Clinical Nutrition, 70,* 1001–1008.

Institute of Medicine (2005). *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids.* Washington, DC: National Academies Press.

International Food Information Council Foundation (2009). *2009 Food and Health Survey: Consumer attitudes toward food, nutrition and health.* Washington DC: International Food Information Council Foundation.

Itoh, M., Johnson, C. B., Cosgrove, G. P., Muir, P. D., & Purchas, R. W. (1999). Intramuscular fatty acid composition of neutral and polar lipids for heavy-weight Angus and Simmental steers finished on pasture or grain. *J Sci Food Agric, 79,* 821–827.

Leaf, D. A., & Hatcher, L. (2009). The effect of lean fish consumption on triglyceride levels. *The Physician and Sportsmedicine, 37,* 37–43.

Li, D., Siriamornpun, S., Wahlqvist, M. L., Mann, N. J., & Sinclair, A. J. (2005). Lean meat and heart health. *Asia Pacific Journal of Clinical Nutrition, 14,* 113–119.

Lopez, E. P., Rice, C., Weddle, D. O., & Rahill, G. J. (2008). The relationship among cardiovascular risk factors, diet patterns, alcohol consumption, and ethnicity among women aged 50 years and older. *Journal of the American Dietetic Association, 108,* 248–256.

Lorenzen, C. L., Hale, D. S., Griffin, D. B., Savell, J. W., Belk, K. E., Frederick, T. L., et al. (1993). National Beef Quality Audit: Survey of producer-related defects and carcass quality and quantity attributes. *Journal of Animal Science, 71,* 1495–1502.

Mahon, A. K., Flynn, M. G., Stewart, L. K., McFarlin, B. K., Iglay, H. B., Mattes, R. D., et al. (2007). Protein intake during energy restriction: effects on body composition and markers of metabolic and cardiovascular health in postmenopausal women. *Journal of the American College of Nutrition, 26,* 182–189.

Mason, C. L., Nicholson, K. L., Brooks, J. C., Delmore, R. J., Henning, W. R., Johnson, D. D., et al. (2009). National Beef Market Basket Survey—2006; External fat thickness measurements and separable component determinations for beef from US retail establishments. *Meat Science, 81,* 335–343.

McKenna, D. R., Roeber, D. L., Bates, P. K., Schmidt, T. B., Hale, D. S., & Griffin (2002). National Beef Quality Audit-2000: Survey of targeted cattle and carcass

characteristics related to quality, quantity, and value of fed steers and heifers. *Journal of Animal Science, 80*, 1212–1222.

Meat Grading and Certification Service (2011). *National summary of meats graded.* Agricultural marketing service. Washington DC: United States Department of Agriculture.

Melanson, K., Gootman, J., Myrdal, A., Kline, G., & Rippe, J. M. (2003). Weight loss and total lipid profile changes in overweight women consuming beef or chicken as the primary protein source. *Nutrition, 19*, 409–414.

Micha, R., Wallace, S. K., & Mozaffarian, D. (2010). Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus. *A systematic review and meta-analysis. Circulation, 121*, 2271–2283.

Mintel, Oxygen (2008). Red Meat-US-December 2008 (market report available for purchase). http://oxygen.mintel.com/sinatra/oxygen/display/id=482976/display/id=297984 Accessed April 11, 2011

National Animal Health Monitoring System (2000). *Implant usage by U. S. feedlots.* Veterinary services, animal and plant health inspection service. Washington DC: United States Department of Agriculture.

North American Limousin Foundation (2011). http://www.nalf.org Accessed April 18, 2011

O'Neil, C. E., Zanovec, M., Keast, D. R., Fulgoni, V. L., 3rd, & Nicklas, T. A. (2011). Nutrient contribution of total and lean beef in diets of US children and adolescents: National Health and Nutrition Examination Survey 1999–2004. *Meat Sci, 87*, 250–256.

Patterson, K. Y., Duvall, M. L., Howe, J. C., & Holden, J. M. (2009). USDA nutrient data set for retail beef cuts, Release 1.0. Available at. http://www.ars.usda.gov/SP2UserFiles/Place/12354500/Data/Beef/Retail_Beef_Cuts01.pdf Accessed April 5, 2011

Red Angus Association of America (2011). http://www.redangus.org Accessed April 18, 2011

Roussell, M. A., Gaugler, T. L., West, S., Vanden Heuvel, J., & Kris-Etherton, P. (2010). Cholesterol-lowering diets with lean beef elicit similar LDL-cholesterol lowering compared with the DASH diet: results from the BOLD (Beef in an Optimal Lean Diet) Study. *Final Program and Abstracts: Joint Conference — 50th Cardiovascular Disease Epidemiology and Prevention-and-Nutrition. Physical Activity and Metabolism, 31*.

Savell, J. W., Brooks, J. C., Delmore, R. J., Griffin, D. B., Gwartney, B. L., Hale, D. S., et al. (2005). Executive Summary 2005 National Beef Market Basket Survey. Available at:http://www.beefresearch.org/CMDocs/BeefResearch/2005%20National%20Beef%20Market%20Basket%20Survey.pdf Accessed May 15, 2011

Savell, J. W., Harris, J. J., Cross, H. R., Hale, D. S., & Beasley, L. C. (1991). National Beef Market Basket Survey. *Journal of Animal Science, 69*, 2883–2893.

Scott, L. W., Dunn, J. K., Pownall, H. J., Brauchi, D. J., McMann, M. C., Herd, J. A., et al. (1994). Effects of beef and chicken consumption on plasma lipid levels in hypercholesterolemic men. *Archives of Internal Medicine, 154*, 1261–1267.

Scott, L. W., Kimball, K. T., Wittels, E. H., Dunn, J. K., Brauchi, D. J., Pownall, H. J., et al. (1991). Effects of a lean beef diet and of a chicken and fish diet on lipoprotein profiles. *Nutrition Metabolism and Cardiovascular Diseases, 1*, 25–30.

Siri-Tarino, P. W., Sun, Q., Hu, F. B., & Krauss, R. M. (2010). Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease. *American Journal of Clinical Nutrition, 91*, 535–546.

United States Department of Agriculture (1990). *Composition of foods: Raw, processed, prepared.* USDA, Human Nutrition Information Services, Handbook No. 8. 1990 Supplement.

United States Department of Agriculture and United States Department of Health, Education, and Welfare (1980). *Nutrition and your health: Dietary guidelines for Americans.* Washington, D.C.: U.S. Government Printing Office.

United States Department of Agriculture and United States Department of Health, & Human, Services (2010). *Dietary guidelines for Americans, 2010* (7th ed.). Washington, DC: U.S. Government Printing Office, December 2010.

United States Department of Agriculture, Agricultural Research Service (2009). Ground beef calculator. Available at. http://www.ars.usda.gov/Services/docs.htm?docid=13933

United States Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory (2010). National nutrient database for standard reference, standard release 23. Available at. http://www.nal.usda.gov/fnic/foodcomp/search Accessed May 15, 2011

United States Department of Agriculture, Food Safety and Inspection Service (2010). *Nutrition labeling of single-ingredient products and ground or chopped meat and poultry products.* Final Rule, 75 Fed. Reg. 82:148 (Dec. 29, 2010).

Watt, B. K., & Merrill, A. L. (1963). Composition of foods: Raw, processed, prepared. *Department of Agriculture, Agriculture Handbook No. 8*. Washington, DC, USA: United States Department of Agriculture.

Wheeler, T. L., Cundiff, L. V., Van Vleck, L. D., Snowder, G. D., Thallman, R. M., Shackelford, S. D., et al. (2006). *Preliminary results from Cycle VIII of the cattle germplasm evaluation program at the Roman L.* Agriculture Research Service, United States Department of Agriculture, Clay Center, NE: Hruska U.S. Meat Animal Research Center.

Wyness, L., Weichselbaum, E., O'Connor, A., Williams, E. B., Benelam, B., Riley, H., & Stanner, S. (2011). Red meat in the diet: An update. *Nutrition Bulletin, 36*, 34–77.

Zanovec, M., O'Neil, C. E., Keast, D. R., Fulgoni, V. L., & Nicklas, T. A. (2010). Lean beef contributes significant amounts of key nutrients to the diets of US adults: National Health and Nutrition Examination Survey 1999–2004. *Nutriton Research, 30*, 375–381.